Name _____ AP Chemistry

Determining Rate Laws Practice

Answer the following questions on a separate sheet of paper.

1) A reaction has two reactants X and Y. What are the order with respect to each reactant and the overall order of the reaction described by the following rate expression?
   (a) Rate = $k[X]^2[Y]$
   (b) Rate = $k[X]$
   (c) Rate = $k[X]^2[Y]^2$
   (d) Rate = k
2) The decomposition of nitrogen dioxide into nitrogen oxide and oxygen gas is a second-order reaction. At 550 K, a 0.250 M sample decomposes at the rate of 1.17 M·min.
   (a) Write the rate expression.
   (b) What is the rate constant at 550 K?
   (c) What is the rate of decomposition when $[NO_2] = 0.800$ M?
3) When a base is added to an aqueous solution of chlorine dioxide gas, the following reaction occurs:

   $$2\ ClO_2\ (aq) + 2\ OH^-\ (aq) \rightarrow ClO_3^-\ (aq) + ClO_2^-\ (aq) + H_2O\ (l)$$

   The reaction rate can be followed by monitoring the hydroxide concentration. The following data are obtained:

$[ClO_2]$ (M)	$[OH^-]$ (M)	Initial Rate (M·s)
0.010	0.030	6.00×10^{-4}
0.010	0.075	1.50×10^{-3}
0.055	0.030	1.82×10^{-2}
0.055	0.062	3.75×10^{-2}

   (a) What is the order of the reaction with respect to chlorine dioxide, hydroxide ion, and overall?
   (b) Write the rate expression for the reaction.
   (c) Calculate k for the reaction.
   (d) When $[ClO_2] = 0.25$ M and $[OH^-] = 0.036$ M, what is the rate of the reaction?
4) The first-order rate constant for the decomposition of a certain drug at 25°C is 0.215 $month^{-1}$.
   (a) If 10.0 g of the drug is stored at 25°C for one year, how many grams of the drug will remain at the end of the year?
   (b) What is the half-life of the drug?
   (c) How long will it take to decompose 65% of the drug?

5) From the following data for the gas-phase isomerization of CH_3NC at 215°C, determine the rate order and calculate the rate constant and half-life for the reaction:

Time (s)	Pressure (torr)
0	502
2000	335
5000	180
8000	95.5
12000	41.7
15000	22.4

6) The decomposition of nitrogen dioxide

$$NO_2\ (g) \rightarrow NO\ (g) + \tfrac{1}{2}\ O_2\ (g)$$

is second-order. It takes 125 s for the concentration of NO_2 to go from 0.800 M to 0.0104 M.

(a) What is the k for the reaction?
(b) What is the half-life of the reaction when the initial concentration of NO_2 is 0.500 M?

7) The equation for the iodination of acetone in acidic solution is

$$CH_3COCH_3\ (aq) + I_2\ (g) \rightarrow CH_3COCH_2I\ (aq) + H^+\ (aq) + I^-\ (aq)$$

The rate of the reaction is found to be dependent not only on the concentration of the reactants but also on the hydrogen ion concentration. Hence the rate expression of this reaction is:

$$\text{Rate} = k[CH_3COCH_3]^m[I_2]^n[H^+]^p$$

The rate is obtained by following the disappearance of iodine using starch as an indicator. The following data are obtained:

$[CH_3COCH_3]$ (M)	$[H^+]$ (M)	$[I_2]$ (M)	Initial Rate (M·s)
0.80	0.20	0.001	4.2×10^{-6}
1.6	0.20	0.001	8.2×10^{-6}
0.80	0.40	0.001	8.7×10^{-6}
0.80	0.20	0.0005	4.3×10^{-5}

(a) What is the order of the reaction with respect to each reactant?
(b) Write the rate expression for the reaction.
(c) Calculate k.